A STUDY of PONDEROSA PINE PRODUCTION in CENTRAL IDAHO

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ECONOMIC SIGNIFICANCE OF THE SPECIES

Ponderosa pine (Pinus ponderosa Laws.) ranks next only to Douglas-fir (Pseudotsuga menziesii /Mirb./ Franco) and the southern pines in volume of timber cut annually in the United States. It is harvested in thirteen western states and the province of British Columbia and thus claims the attention of forest managers over a considerable area.

The ponderosa pine type is commonly the lowest altitudinally of western commercial forests of the mountain country and consequently serves, directly and indirectly, as a major source of economic usefulness. Water and its quality, the pulse of existence and farming in the arid valleys are influenced by the pine type; millions of people picnic, hike, fish, and hunt over the vast areas supporting it. The wood has desirable and valuable properties and hence finds specialized and varied uses in all parts of the continent.

PROBLEMS OF MANAGEMENT

Management problems of the ponderosa pine type are distinct and complex but do not defy solution. Growing where precipitation is usually close to 23 inches annually and where summer rainfall is commonly below an inch, found on basaltic, sandstone, limestone, or desiccative granitic soils often in rugged terrain where logging is formidable and costly, where fire risk from lightning storms and the human element is high, ponderosa pine management challenges the resourcefulness of both the researcher and the manager.

Of the many aspects of management perhaps the most important is the difficulty of securing high growth per acre. How to cut ponderosa pine forests and secure a net growth of 150 feet board measure per acre per year in the residual stand requires skill and prescience possessed by few silviculturists. The brief annual growth period, the scant rainfall, the low water-holding capacity of the soil, the relatively few frost-free days, and the timber-killing insects, all combine to aggravate conditions already difficult for acceptable net growth although growth per se is reasonable enough. Mortality of sawtimber is mostly due to insects of which the western pine beetle (Dendroctonus brevicomis Lec.) is by far the most important although the mountain pine beetle (Dendroctonus monticolae Hopk.), the pine butterfly (Neophasia menapia Feld.), and Ips are among the more important latent threats. Neither is there assurance that the difficulty of reducing

mortality will diminish as the older age classes are removed because entomologists believe the emphasis may shift to other insects in the younger age classes in the discernible future.

While disease can be a factor of measurable proportions in reducing net growth, it is fortunately not as widespread nor as severe as the loss from insects. It is nevertheless becoming increasingly important, and means and technics for recognizing incidence and coping with outbreaks are now accepted more realistically than heretofore.

Of all phases of ponderosa pine management the establishment of reproduction is the most troublesome and certainly the most frustrating. The absence of seed crop periodicity, the seed-eating rodents and birds, the low precipitation--a vital factor in the first few years of growth--the high soil surface temperatures generated in summer, and the competing vegetation, all combine to militate against the natural or artificial replacement of growing stock on cutover areas. The coincidence of abundant seed and ample precipitation the following spring and summer, which is necessary for successful stocking, is infrequent and unpredictable. The Black Hills alone invariably enjoys this fortuitous combination. This obstacle of securing reproduction aggravates the difficulty of planning and applying regulation, the keystone to successful sustained yield management of all forest crops. Reproduction already present in pine forests all too often gives the impression that it is easy to secure. Nothing could be further from the truth. Unless sense and caution are exercised, crop establishment can represent an impressive investment per acre. It should be evident to all that every means at the forest manager's disposal should be directed towards reducing damage to advance reproduction during logging, a field where greater effort is needed.

While many extensive areas supporting ponderosa pine are of gentle topography many others including central Idaho, western Montana, and some parts of Oregon are not. This means increased logging expense, more damage to precious advance reproduction, and costlier postlogging measures where soil is erosible as in central Idaho.

Unlike many forest types, no market exists for ponderosa pine thinnings which is an obvious disadvantage in the management of immature stands. The Coconino Plateau in Arizona is a conspicuous exception. While this difficulty may be overcome within a reasonable time, spurred by the rapid development of utilization standards and regional economic trends, present means of profitable timber stand improvement practice are limited in scope. This is unfortunate because all ponderosa pine forests are deficient in intermediate-size classes. Thus there is lost a direct means of profitably increasing the growth rate of the smaller sized stems to sustain a continuous flow of merchantable material in later cuts. The lack of thinning practice also has an adverse effect on the results of artificial pruning, a necessary practice if high-quality lumber is to be produced on short rotations,

because in unthinned stands diameter growth is only moderate which results in slower healing of branch cuts. The cost of this pruning is an outright gamble on future market demand and assumes that the current price differential between high and low lumber grades will persist indefinitely. While this may be a logical and reasonably safe prediction, artificial pruning is nevertheless one more cost of management.

THE EXPERIMENT

The many problems of ponderosa pine management related above are common to the type throughout the Intermountain country. The study described here was formulated and initiated as a result of a problem analysis made for forest management research in the Intermountain Region[1/] in which all problems were listed and considered in order of priority. Because the need for better silvicultural management of ponderosa pine transcended all others, it was decided to initiate an experiment which would help to answer the most urgent problems. The main objectives of the experiment are therefore:

A. To discover how to cut and log mature ponderosa pine to insure the highest possible net growth per acre, minimum damage to site and advance growth, and the successful establishment of reproduction.

B. In conjunction with trials of cutting to secure detailed growth data which would permit reliable predictions of net sawtimber growth.

C. To develop economically and silvically sound treatments to improve composition, growth, and quality of sapling and pole stands.

In designing the experiment, it was important to keep the number of variables to a minimum, and to employ them in a way which would permit biometric analysis. The variables to be tested were carefully chosen and were considered to be basic and decisive in their influence on the establishment and growth of seedlings and the development of young stands to maturity. Thus the danger of the study becoming outmoded was permanently minimized. The two reproduction (marking) methods, for example, represent classic and commonly misunderstood silvicultural systems-stem (individual tree) selection and group selection. These two systems produce strikingly different environmental conditions affecting

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1/ Curtis, James D. 1949. A problem analysis for forest management research in the Intermountain Region. Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden, Utah. Unpub. ms. 45 pp.

establishment and growth of trees such as seed supply, light, seedbed, soil moisture availability, and later the evenaged and unevenaged character of individual stands.

Similarly, the two levels of reserve volume include variations in many stand characteristics which influence subsequent growth of residual trees as well as the regeneration of the next crop.

The two tractors chosen represented the practicable extremes in logging "cats" and indirectly produced measurable variations in soil disturbance, damage to advance growth, and erosion hazard. Lastly, the volume of the original stand reflects important differences in site quality with all the ramifications in tree vigor and surface vegetation which, in turn, affect regeneration and growth.

Accordingly, these four variables, (1) reproduction method, (2) level of reserve, (3) size of tractor, and (4) stand volume class were included in the design. Eight combinations are possible among the first three of these variables, and these combinations were established on eight compartments (minor drainages). The compartments were then split three ways according to the three levels of original stand volume. Finally, the eight compartments were replicated to make 16 in all. Figure 1 shows one replication of eight compartments starting with the original stands and the treatments imposed on them.

THE INSTALLATION

The first step in the installation was the identification and location of minor operable drainages on the Boise Basin Experimental Forest which would serve as "plots" or areas of comparison. These were called compartments. It was necessary that they approximate at least 30 to 50 acres in extent so that each contained the three volume classes decided on as readily identifiable. This was accomplished by use of aerial photographs and stereograms.[2/] These three volume classes or treatment units, each of which contains a minimum of 10 acres in each compartment, were:

Volume Class I averaging - 0 - 10,000 f.b.m. per acre
Volume Class II averaging - 10 - 20,000 f.b.m. per acre
Volume Class III averaging - 20,000 or more f.b.m. per acre

2/ Wilson, Alvin K. 1954. Delineating ponderosa pine volume and site quality classes from aerial photographs. Research Paper 34, Intermountain Forest and Range Expt. Station, Forest Service, Ogden, Utah.

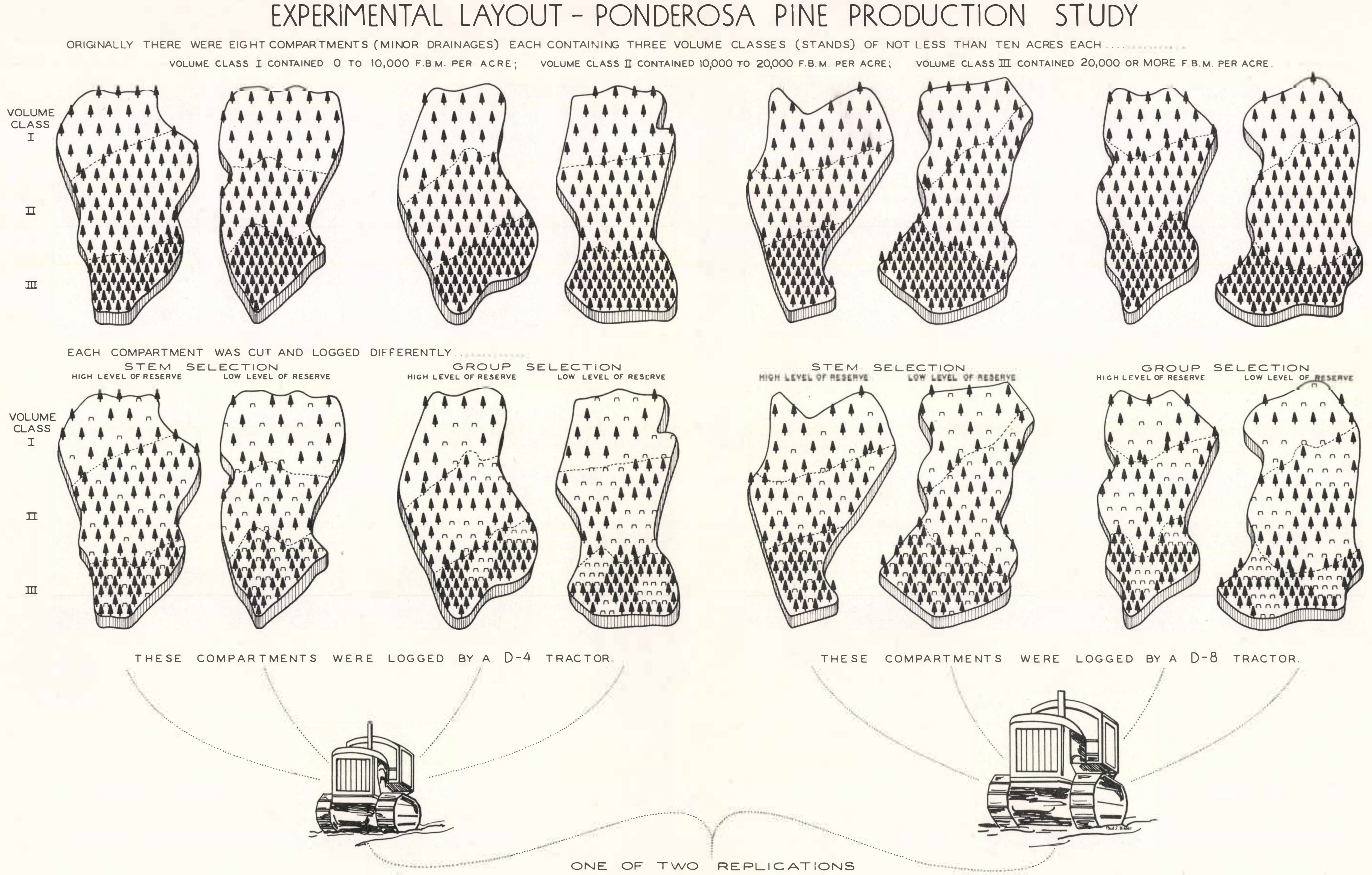
EXPERIMENTAL LAYOUT - PONDEROSA PINE PRODUCTION STUDY
ORIGINALLY THERE WERE EIGHT COMPARTMENTS (MINOR DRAINAGES) EACH CONTAINING THREE VOLUME CLASSES (STANDS) OF NOT LESS THAN TEN ACRES EACH ...
VOLUME CLASS I CONTAINED 0 TO 10,000 F.B.M. PER ACRE; VOLUME CLASS II CONTAINED 10,000 TO 20,000 F.B.M. PER ACRE; VOLUME CLASS III CONTAINED 20,000 OR MORE F.B.M. PER ACRE.
VOLUME CLASS I
II
III
EACH COMPARTMENT WAS CUT AND LOGGED DIFFERENTLY...
STEM SELECTION
HIGH LEVEL OF RESERVE
LOW LEVEL OF RESERVE
GROUP SELECTION
HIGH LEVEL OF RESERVE
LOW LEVEL OF RESERVE
STEM SELECTION
HIGH LEVEL OF RESERVE
LOW LEVEL OF RESERVE
GROUP SELECTION
HIGH LEVEL OF RESERVE
LOW LEVEL OF RESERVE
VOLUME CLASS I
II
III
THESE COMPARTMENTS WERE LOGGED BY A D-4 TRACTOR.
THESE COMPARTMENTS WERE LOGGED BY A D-8 TRACTOR.
ONE OF TWO REPLICATIONS

FIGURE 1.

There are two replicates of 8 compartments each, a total of 847 acres. Compartment boundaries are marked on trees in the field by yellow paint spots; volume class boundaries by blue paint spots. Each compartment was cruised by classes and all trees numbered with temporary cardboard tags. Number, species, diameter, risk and/or tree class[3/], [4/], [5/] were recorded for each tree 11.0 inches d.b.h. and over.

Reproduction Methods.--Two reproduction (marking) methods are being tested--Stem Selection and Group Selection. In the former, effort is directed towards removing those individuals which it is believed will not live until the end of the 15-year cutting cycle with the purpose of increasing net growth per acre by reducing volume mortality. Briefly, this method assumes that mortality is always latent, even in the younger age classes--a fact which previous research has shown to be true. It might be adduced that because ponderosa pine is an intolerant species it is not suitably manageable under stemwise selection. The fact is that loss from sawtimber mortality cannot be systematically minimized otherwise except by removal of all merchantable trees. This would be undesirable where the objective is to secure and to sustain a high net growth rate. Because the species is naturally disposed to occur groupwise, stand structure need not be greatly disturbed by this system of cutting but net growth can be substantially increased.

In Group Selection the overmature and mature trees are clear cut in groups, commonly from 0.25 to 0.75 acre in area. The size of the group is largely determined by the size of the stand to be cut although occasionally two small stands, slightly separated, can be "joined" thus making a more workable unit. The clear-cut groups are therefore the initial stage of small even-aged stands which are separated from other even-aged stands by virtue of this discontinuity of cutting and with obvious advantages of protection. It follows that the development and treatment of these separate stands are facilitated and are desirable silvically because of their even-agedness and homogeneity.

Because the initial stands of each volume class varied both in volume and risk, it was not possible to have reserve stands equal in risk though they were equal in volume for corresponding levels of reserve. With few exceptions, however, all (Salman-Bongberg) risk classes

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3/ Salman, K. A. and J. W. Bongberg. 1942. Logging high-risk trees to control insects in the pine stands of northeastern California. Jour. Forestry 40: 533-539.

4/ Keen, F. P. 1943. Ponderosa pine classes redefined. Jour. Forestry 41: 249-253.

5/ Wilson, Alvin K. 1952. An age-vigor tree classification for Douglas-fir in central Idaho. Jour. Forestry 50: 929-933.

III and IV were removed by cutting in the two methods of reproduction or marking. Rotation age for both methods is tentatively set at 180 years.

In the Stem Selection method, trees of highest mortality risk (S-B IV and III, Keen 4D, 3D, 3C) were marked first followed by those of next highest risk until the specified average per acre reserve volume for the particular volume class area was reached. Because all risk classes were available from cruise sheets and each tree numbered, it was a simple task to relocate the trees to be marked. In the Group Selection method, the area of each stand for a volume class was taken from the stand map of each compartment. On the basis of a 180-year rotation and cutting every 30 years to establish reproduction, there will be six age classes and the area occupied by any one of them will be one-sixth of the total area of the unit, in this case the area occupied by a volume class. Control of cutting, therefore, was achieved by first marking the groups of overmature trees with no understory until the predetermined area quota for the youngest (reproduction) age class was met. This is followed by selecting stands which occurred as overstory above seedlings or saplings, thus freeing to grow the next older age class, equal in area to the youngest age class. Likewise, the next step was to remove overstory over poles.

This scheme was continued as far as area allotments and the prescribed level of reserve would allow. In many cases, a stage was reached in marking where the remainder of the allowable cut was insufficient for further effective work toward the attainment of groupwise stand structure. This situation can be expected in initial cuttings of this kind, especially where there is a deficiency or excess of a particular age class. In such cases, individual high-risk trees between the groups were marked, until the desired level of reserve was met. In following this system a substantial number of high-risk trees were automatically removed and hence a two-fold purpose in management was achieved with attendant and obvious advantages. Cuts to "shape up" groups (to delineate them better) and decrease mortality risk will be made 15 years after each reproduction cut. It should be obvious that the degree of refinement used in installing the cutting systems in this experiment, would not be employed in their application.

Levels of Reserve.--Two levels of reserve stand volume per acre were employed in each reproduction method-logging method combination for each volume class. The absolute values, approximated within a few board feet per acre in the actual marking, are as follows:

Volume class	High reserve	Low reserve
	F.b.m. per acre	
I	6,000	4,000
II	11,000	8,000
III	18,500	14,500

Logging Method.--Two sizes of tractors were employed to gage the damage to advance reproduction and to compare logging costs in each reproduction method-level of reserve combination in each of the three initial volume classes. Machines used were D-4 and D-8 caterpillar tractors without bulldozer blades which probably represent the practical extremes of tractor size for logging in the rough southern Idaho terrain.

Stocking and Growth Measurements.--In advance of the logging, hubs (permanently staked points) from which "arms" (0.2 x 1.0 ch.) extended in the four cardinal directions were located randomly in each volume class of the two replicates (16 compartments, or minor drainages). By means of this (sampling) scheme, stocking of seedlings, saplings, and poles, and data for measurement of diameter growth were recorded, thus allowing stand and stock tables, reproduction stock tables, reproduction stocking figures to be computed prior to the first logging and at any subsequent time thereafter.

Sale Contract.--The 4,311,500 f.b.m. of timber involved in the cutting were disposed of by means of an S-25 Sale Contract administered by personnel of the Boise National Forest. Careful planning and fine cooperation between the Intermountain Forest and Range Experiment Station, the Boise National Forest, and the Boise-Payette Lumber Company enabled the project to be carried through virtually as anticipated.

Other Considerations.--In view of the erosibility of the coarse granitic soils of southern Idaho it was considered a good opportunity to measure the effects of skidding under different methods and severities of cutting as it affected soil movement. The Division of Watershed Management is cooperating to the extent of measuring these effects, and has constructed sediment traps on the study area and recorded appropriate data from which deductions could be made regarding rates of soil movement.

Because the mortality of sawtimber affects net growth so substantially, the Divisions of Forest Insects and Forest Disease Research are also cooperating actively in the experiment. Entomologists and pathologists from these divisions are developing criteria which will assist the timber marker in selecting trees which are diseased or which are vulnerable to insect attack.

Several precautions were taken before and during the sale which were believed to be good management practice. The 7.2 miles of logging spur roads were flagged out prior to felling. Grades generally were under 8 percent with steeper pitches up to about 18 percent which resulted in less road construction and soil disturbance than if grade standards had been slavishly observed. Spur roads were kept sufficiently far above the drainage bottoms that a 10-foot strip of undisturbed vegetation lay between the lower edge of the overspill and creekbed to avoid sediment loss.

Fallers were instructed to fell trees uphill or downhill wherever possible to lessen damage to advance reproduction in skidding and to allow safer working conditions for the "Cat" skinners. They were also instructed to bunch their fellings where groups of trees were marked for cutting and to fell all snags over 10 feet high. Cat skinners were instructed to use the same skid trail where possible--thus minimizing damage to potential sawtimber--not to skid down ravines, not to "siwash" turns of logs around saplings and poles, and to avoid all reasonable damage to standing trees regardless of size. No blades on cats were permitted. Before they moved into the woods, each faller and cat skinner was given by the wood's boss a shirt-pocket size tersely worded instruction book explaining the experiment, the numerous tree markings, reminding them of the important sale regulations, and asking their cooperation. Individual compartment maps showing location of marked trees and volume class boundaries were likewise prepared and distributed. These aids proved eminently successful and suggest a means of employer-worker cooperation not yet fully exploited.

On completion of skidding, grass seed was sown on skid trails and slash was treated according to national forest standards except on skid trails where special measures were taken to slow water and soil movement. This slash was placed in piles at intervals. The smaller material of needles and twigs was placed in the deepest part of the skid trail and the heavier limbs placed on top lengthwise with the trails to keep it in contact with the soil. A discretionary standard of number per length of skid trail was adopted depending on grade as follows:

Grade percent:	to 30	31-60	61-90
Spacing of piles-feet:	50	30	10

In a few critical locations where slash was unavailable, cross ditches were shovelled at corresponding distances.

After the logs were removed from the woods, the haul roads were ditched according to arbitrary standards suggested by the Division of Watershed Management as follows:

Grade percent:	0-5	6-10	11-15	15+
Spacing - feet:	100	75	50	25

The spacings of both slash "plugs" and ditches may require modification, the direction of which will be revealed by results of the study. Owing to early frosts in the fall after logging, it was necessary in some instances to construct dikes and leave ditching until spring. This resulted in what appears to be unnecessarily high soil banks on the spur roads.

RESULTS--PRESENT AND FUTURE

It is a common belief, even among many foresters, that useful results from studies such as the one just described, will be many years reaching fruition. This is unfortunate because actually it is not the case. A year since the installation of this experiment in timber production has not passed, and yet worthwhile and applicable information is at hand. Some research techniques employed are new and yet their use greatly decreased the work and demonstrated their possibilities. The practicability of using D-4 tractors on steep ground to move logs which contained up to 3,600 board feet of volume was questioned and yet its performance clearly revealed the advantages and the limitations of this size of tractor for efficient skidding in typical central Idaho topography. It was believed by others that felling up and down hill would result in inordinate breakage, and yet it actually facilitated skidding, made for safer work conditions, and reduced damage.

There is available an excellent sample of virgin forest stand and stock tables covering a 100-percent cruise of trees above 11 inches d.b.h. together with an appraisal of risk by three tree classifications on an 847-acre area. Forest managers can study the resulting stand structure, risk reduction, and risk condition of stands not less than 10 acres in extent that have been cut by two methods of marking two reserve stand volume levels, logged by two different sizes of tractor, in three stands of different initial volumes per acre. Furthermore, these conditions can be examined and compared on the ground. The costs of logging these different stands (16 minor drainages) are known, and the tractor decking arms first contrived by the logger on the D-4 cat and later used on the larger one, has been employed by other operators. It is known that standardized skid-trail "plugs" and logging-road cross ditches are desirable and feasible. Refinements will crystallize these standards.

Within a year, damage and mortality of stems up to 11 inches d.b.h. and the consequent reduction in stocking of young trees will be known accurately. In subsequent years, saw-tree mortality will indicate the efficacy of the marking systems and the levels of reserve used in relation to initial stand volumes. Likewise, knowledge of the stimulation of seed production, the establishment rate of natural regeneration, and the effects of competing vegetation will become available.

After 5 years, comparisons of the effects of the different marking methods on net sawtimber growth will be available as well as accurate data for the growth of stands cut in the different ways. All this information is indispensable for the forest manager if he is to manage this important timber resource for multiple use and full production of wood crops.